High-Strength Composite Fabric Tested at Structural Benchmark Test Facility

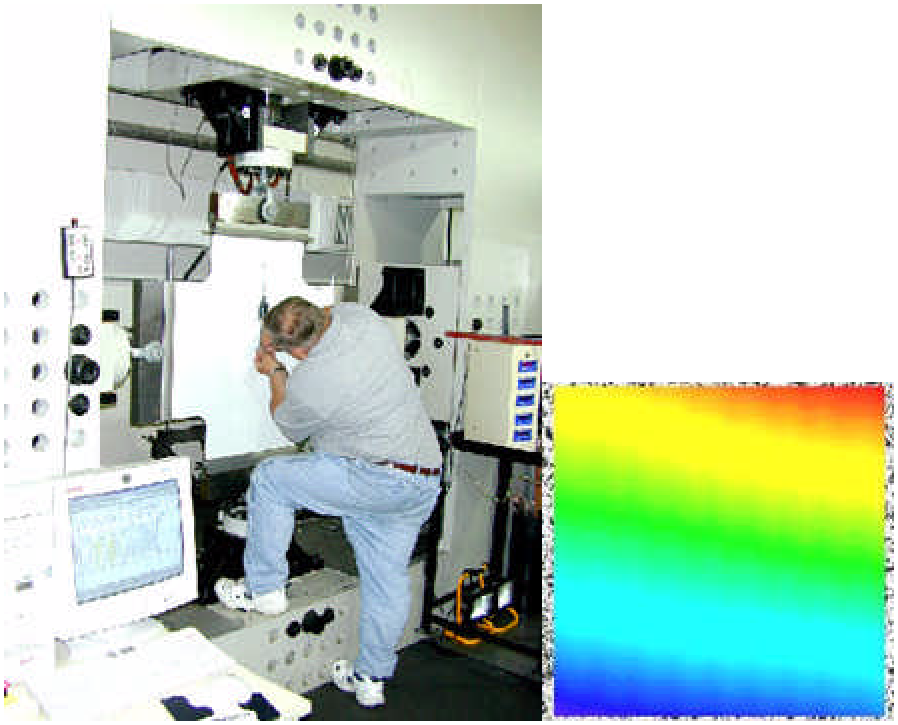
Large sheets of ultrahigh strength fabric were put to the test at NASA Glenn Research Center's Structural Benchmark Test Facility. The material was stretched like a snare drum head until the last ounce of strength was reached, when it burst with a cacophonous release of tension. Along the way, the 3-ft square samples were also pulled, warped, tweaked, pinched, and yanked to predict the material's physical reactions to the many loads that it will experience during its proposed use.

The material tested was a unique multi-ply composite fabric, reinforced with fibers that had a tensile strength eight times that of common carbon steel. The fiber plies were oriented at 0° and 90° to provide great membrane stiffness, as well as oriented at ±45° to provide an unusually high resistance to shear distortion. The fabric's heritage is in astronaut space suits and other NASA programs.

Increased demands are being made on materials for higher serviceability, more severe environments, and greater reliability. This has driven a need to better understand the mechanical properties of this composite fabric material. The Raytheon Company, Electronics Systems Division entered into a cost-reimbursable Space Act Agreement with NASA to conduct a series of tests on the fabric using Glenn's Life Prediction Branch's materials testing capabilities.

Raytheon provided 36- by 36-in. cross-shaped cruciform fabric specimens for testing in the Structural Benchmark Test Facility's 100,000-lb capacity in-plane load frame. An optical full-field strain-measurement system based on speckle-pattern correlation was employed to accurately measure material strains as the various loadings were applied.

The test program accurately characterized the stress-strain behavior of the novel fabric. Extensional and rotational elastic moduli and Poisson's ratios along the principal material axes were determined for over 120 load levels and biaxial load ratios. The test results already are proving useful in improved understanding of the material and for developing recommendations for material design changes. In the end, the testing will lead to more efficient and greater use, higher durability, longer life, and improved safety and reliability for fabric material designs.



Left: The in-plane biaxial load frame with fabric specimen mounted. Right: Fabric specimen under large equibiaxial load with measured vertical displacement field superimposed.

Find out more about this research:

Glenn's Life Prediction Branch http://www.grc.nasa.gov/WWW/LPB/

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